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Effectiveness of a pharmacist-led educational intervention to reduce the use of high-risk abbreviations in an acute care setting in Saudi Arabia: a quasi-experimental study

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ABSTRACT

Objectives: To evaluate the effectiveness of a pharmacist-led educational intervention to reduce the use of high-risk abbreviations (HRAs) by healthcare professionals.

Design: Quasi-experimental study consisting of a single group before-and-after study design.

Setting: A public emergency hospital in Mecca, Saudi Arabia.

Participants: 660 (preintervention) and then 498 (postintervention) handwritten physician orders, medication administration records (MRAs) and pharmacy dispensing sheets of 482 and 388 patients, respectively, from emergency wards, inpatient settings and the pharmacy department were reviewed.

Intervention: The intervention consisted of a series of interactive lectures delivered by an experienced clinical pharmacist to all hospital staff members and dissemination of educational tools (flash cards, printed list of HRAs, awareness posters) designed in line with the recommendations of the Institute for Safe Medical Practices and the US Food and Drug Administration. The duration of intervention was from April to May 2011.

Main outcome: Reduction in the incidence of HRAs use from the preintervention to postintervention study period.

Findings: The five most common abbreviations recorded prior to the interventions were 'IJ for injection' (28.6%), 'SC for subcutaneous' (17.4%), drug name and dose running together (9.7%), 'OD for once daily' (5.8%) and 'D/C for discharge' (4.3%). The incidence of the use of HRAs was highest in discharge prescriptions and dispensing records (72.7%) followed by prescriptions from in-patient wards (47.3%). After the intervention, the overall incidence of HRA was significantly reduced by 52% (ie, 53.6% vs 25.5%; p=0.001). In addition, there was a statistically significant reduction in the incidence of HRAs across all three settings: the pharmacy department (72.7% vs 39.3%), inpatient settings (47.3% vs 23.3%) and emergency wards (40.9% vs 10.7%).

Conclusions: Pharmacist-led educational interventions can significantly reduce the use of HRAs by healthcare providers. Future research should investigate the long-term effectiveness of such educational interventions through a randomised controlled trial.

Strengths and limitations of this study

- This is the first adequately powered study to evaluate the effectiveness of a pharmacist-led educational intervention to reduce the incidence of high-risk abbreviations (HRAs) in an acute care setting.
- A quasi-experimental design is best suited to evaluate the effectiveness of an intervention when conducting a randomised controlled trial is not logistically feasible.
- Findings from the present study can assist policymakers to design policies to encourage safe prescribing practices, thus reducing medication errors.
- Quasi-experimental studies using a single group before-and-after study design have poor internal validity.
- We could not study the negative consequences (eg, adverse drug reactions) of using HRAs and the impact of reducing the incidence of using HRAs on patient safety.

INTRODUCTION

Medication errors are one of the major causes of morbidity and mortality globally and the most prevalent error in medical care.[1] These errors can occur while

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prescribing, dispensing and administering medicines, and most of them are preventable before they harm patients.[1 2] In hospitals, prescription and administration errors are major threats to patient safety, with an estimated incidence of 18.9–58.4%.[1–5] There are many reasons why medication errors occur, but in most cases the errors can be linked to poor communication or transcribing of the physician's message. A contributing factor in poor communication is the use of shorthand or ambiguous abbreviations when writing prescriptions.[5] Although the use of abbreviations is time saving, it does not promote patient safety.[6 7] In the USA, it has been estimated that ~5% of medication errors reported in medical care are associated with the use of unsafe abbreviations leading to patient harm.[8]

Using shorthand or abbreviations in prescriptions tends to become habitual practice if not discouraged. On-the-job training or educational activities have been shown to be a significant help in the eradication of this habit, with several studies having confirmed that educational interventions are an effective tool for the improvement of prescribing skills and, consequently, patient safety.[9–12] The Institute for Safe Medical Practices (ISMP), together with the US Food and Drug Administration (FDA), launched a nationwide educational campaign in 2006 to prevent the use of unsafe and error-prone abbreviations in healthcare facilities and developed a list of abbreviations, symbols and dose designations that should be avoided while communicating all sorts of medical information.[13 14] Subsequently, many countries have followed suit. For instance, the New South Wales Therapeutics Advisory Group (NSWTAG) developed quality indicators according to the ISMP and FDA recommendations to discontinue the use of abbreviations in Australian hospitals.[15]

Another concept that has been the focus of attention in this regard is the increased emphasis on promoting a safety culture during the teaching and training of medical students and residents.[7–9] Pharmacist-led educational interventions have been shown to improve safe prescribing practices as well.[12]

Like any other country, medication errors are of great concern in Saudi Arabia. Although the overall incidence of medication errors in the Kingdom is not available, studies have reported a prescribing error incidence of 8–56 per 100 medication orders in hospitalised patients.[16 17] In Saudi Arabia, the healthcare workforce largely consists of expatriates educated and trained in different countries including, but not limited to, the UK, the USA, India, Pakistan, Egypt, Malaysia and the Philippines. In addition, Saudi Arabia attracts more than 10 million pilgrims across the globe to visit holy mosques each year who receive free medical treatment, if required. Therefore, given the high number of patients and diversity of healthcare workforce (in terms of culture, language, clinical education and training), healthcare providers may use high-risk abbreviations (HRA) that could in turn lead to prescribing, transcribing and administration errors, especially in acute care facilities dealing with pilgrims. To the best of our knowledge, no study has evaluated the extent of use of HRAs in an acute care setting and impact of a pharmacist-led educational intervention to reduce the use of HRAs. Therefore, the aim of this study was to evaluate the effectiveness of a pharmacist-led educational intervention to reduce the use of HRA by healthcare professionals (ie, doctors, nurses, pharmacists and relevant assistants) in an acute care setting.

Method

A quasi-experimental study using a single group before-and-after intervention design[18] was conducted from 1 February 2011 to 1 July 2011. Although randomised controlled trials (RCTs) are best suited to evaluate the effectiveness of an intervention,[19] we were unable to design an RCT due to the unavailability of a suitable control group. The limitations of using a quasi-experimental design are further discussed in the limitations section. The primary outcome was reduction in the incidence of HRAs, as a proportion of all prescriptions, from the preintervention to postintervention period.

Settings

The study was conducted at an acute care facility specially designated for pilgrims visiting Majsid-Al-Haram (The Grand Mosque), Mecca, Saudi Arabia. The hospital on average provides emergency care to more than 5000 pilgrims a year. In addition to the outpatient department and the pharmacy department, the hospital has a 10-bed Coronary Care Unit (CCU) and 10-bed Intensive Care Unit (ICU).

Identification of prescriptions with HRA

During the study period, electronic prescribing was limited to inpatient physician orders only. All handwritten physician orders, medication administration records (MRAs) and pharmacy dispensing sheets from the inpatient (ICU and CCU), outpatient (male and female emergency wards) and pharmacy departments were reviewed for HRAs by six senior pharmacy students, who had received formal training in clinical research and data collection, under the direct supervision of the first author (AH). For the purpose of this study, HRAs referred to 'medical abbreviations, dose designations, drug names, or symbols considered unsafe and likely to result in misinterpretation.' These were identified on the basis of the ISMP's list of error-prone abbreviations by a team of experienced pharmacists based on hospital usage.[13] At first, 62 abbreviations were selected, but these were later narrowed down to 32 items, based on the frequency of use and severity of the consequences. Details of abbreviations are listed in table 1.

Sample size

The sample size for this study was estimated on the basis of the method previously adopted by Abushaiqa *et al*.[12]

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Table 1 List of high-risk abbreviations used in this study

	High-risk item	Intended meaning	Possible misinterpretation	Preferred correction
	Abbreviations			
1.	µg	Microgram	mg	Write 'mcg'
2.	BT	Bedtime	BID (twice daily)	Use 'bedtime'
3.	cc	Cubic centimetres	u (units)	Use 'mL'
4.	D/C	Discharge or discontinue	Either one	Use 'discharge' or 'discontinue'
5.	IJ	Injection	IV or intrajugular	Injection
6.	HS	Bedtime or half-strength	Either one	Use 'bedtime' or 'half-strength'
7.	IU	International units	IV or 10 (ten)	Use 'units'
8.	o.d. or OD	Once daily	Right eye, leading to oral liquid instilled in to the eye	Use 'daily'
9.	q.d. or QD	Every day	q.i.d.(four times daily)	Use 'daily'
10.	q.o.d. or QOD	Every other day	q.d. or q.i.d.	Use 'every other day'
11.	SC, SQ, sub q	Subcutaneous	SC as SL (sublingual), SQ as '5 every', q as 'every'	Use 'subcut' or 'subcutaneously'
12.	ss	Sliding scale (insulin) or 1/2	'55'	Spell out 'sliding scale' or use 'one-half' or '1/2'
13.	U or u			
	Dose designations and other information			
14.	Trailing zero after a decimal point (eg, 1.0 mg)	1 mg	10 mg if the decimal point is not seen	Express in whole numbers
15.	No leading zero before a decimal point (eg, 0.5 mg)	0.5 mg	5 mg if the decimal point is not seen	Use zero before the decimal point
16.	Drug name and dose run together, especially for "L" ended drugs (eg, Tegretol300 mg)	Tegretol 300 mg	Tegretol 1300 mg	Place enough space between the drug, dose, and unit
17.	Numerical dose and unit of measure run together (eg, 10 mg, 100 mL)	10 mg, 100 mL	The 'm' might be mistaken as a zero or two zeros	Place enough space between the dose and unit
18.	Unit abbreviations with a period (eg, mg. or mL.)	mg, mL	The 'period' might be mistaken as '1'	Use mg, mL, etc without a period
19.	Large doses without properly placed commas (eg, 100 000 units)	100 000 units	The '100 000' might be mistaken as '10 000'	Use commas for doses above '1000' or write '100 thousand' instead
20.	ASA	Aspirin or acetylsalicylic acid	5-ASA (5-aminosalicylic acid or mesalazine) or azathioprine	Use 'aspirin'
21.	HCL	Hydrochloric acid or hydrochloride	The 'H' is misinterpreted as 'K'—potassium chloride	Use complete drug name unless expressed as a drug salt
22.	HCT	Hydrocortisone	Hydrochlorothiazide	Use complete drug name
23.	HCTZ	Hydrochlorothiazide	Hydrocortisone seen as HCT 250 mg	Use complete drug name
24.	MgSO4	Magnesium sulfate	Morphine sulfate	Use complete drug name
25.	MS, MSO4	Morphine sulfate	Magnesium sulfate	Use complete drug name
26.	MTX	Methotrexate	Mitoxantrone	Use complete drug name
27.	ZnSO4	Zinc sulfate	Morphine sulfate	Use complete drug name
	Symbols			
28.	> and <	Greater than and less than	Mistaken as opposite of intended; '<10' mistaken as '40'	Use 'greater than' or 'less than'
29.	/ (slash)	Separates two doses or indicates 'per'	Mistaken as the number '1', eg, 25 units/10 units misread as '25 units and 110 units'	Use 'per' rather than a slash mark to separate doses
30.	@ (at sign)	At	Mistaken as '2'	Use 'at'
31.	& (ampersand)	And	Mistaken as '2'	Use 'and'
32.	+ (plus sign)	Plus or and	Mistaken as '4'	Use 'and'

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Taking into account a one-tailed significance level (α=0.05), β=0.2 and incomplete data (20%), the minimum number of prescriptions required for before-and-after-intervention assessment was 130. However, keeping in mind the chances of sampling errors and limitations of a quasi-experimental single group pretest post-test design, it was decided to review all the prescriptions for at least 1 month before and after the intervention.

Study instruments

A standardised, structured data collection form was designed on the basis of the criteria presented under the quality indicators developed by the New South Wales Therapeutic Advisory Group and Clinical Excellence Commission.[15] Section one of the questionnaire gathered information about patient demographics, section two gathered information about the prescribing source and prescriber's name, and finally the third section consisted of the list of HRAs. The content validity of the tool was assessed by the team members and was piloted to test its validity on the first 20 prescriptions.

Pharmacist intervention

Pretest assessment: This part of the study was designed to get the baseline data about the incidence of HRAs in the study setting. The preassessment phase was initiated in the first week of February 2011 and lasted until the first week of March 2011. Data about the HRAs were collected from all handwritten physician orders, medication administration records and pharmacy dispensing sheets during the study period.

Educational intervention: After collecting the initial data, the educational intervention was undertaken from 2 April to 2 May 2011. The educational intervention was led by an experienced pharmacist with postgraduate qualification in clinical pharmacy (AH) and assisted by senior pharmacy students trained by the research team. The educational intervention was delivered to all healthcare providers and was designed in accordance with the recommendations of ISMP[13] and the US Food and Drug Administration.[14] The educational tools included in the intervention were:

- A printed list of abbreviations on brightly coloured paper that was inserted into medical records/patient charts, placed next to all hospital computers and posted in the patient care area;[20 21]
- Pocket-sized flash cards with the HRA list provided for all staff;
- Laminated copies of the list attached to the back of the physician's order divider in medical records;
- Patient safety posters given to the hospital wards explaining the HRAs.

All hospital staff, including physicians, nurses, pharmacists and related staff (~250 people), were requested to attend a series of educational sessions during the intervention phase. The interactive lectures were delivered by AH. The lectures highlighted the basic concepts of medication, prescribing and dispensing errors and negative consequences of using HRAs in emergency settings. In addition, methods of avoiding medication errors and use of HRAs were also discussed. To make sure that all staff were aware of this campaign, each staff member was required to sign a form to confirm that they had received the list and agreed not to use the dangerous abbreviations. At the end of each session, a certificate of attendance was issued to each staff member. Additionally, the research team distributed educational tools (laminated pocket cards with the HRA list, pens and tea mugs with an abbreviation logo) to all participants at the end of the lectures.[22]

Post-test assessment

In the final phase, postintervention, all prescriptions written during the 1 month (June to July 2011) from

Table 2 Prescriptions with high-risk abbreviations across three sources categorised according to whether they were preintervention or postintervention

Prescription source	Preintervention		Postintervention		IRD† (%)	χ^2 (df=1)
	Number of patients	Incidence* (%)	Number of patients	Incidence* (%)		
Hospital emergency wards (M/F emergency departments)	42	40.9 (90/220)	30	10.7 (15/140)	73.8	37.756‡
Pharmacy department	220	72.7 (160/220)	178	39.3 (70/178)	45.9	45.001‡
Inpatient settings	220	47.3 (104/220)	180	23.3 (42/180)	50.7	24.479‡
Total	482	53.6 (354/660)	388	25.5 (127/498)	52.4	92.517‡

*Incidence of high-risk abbreviation use calculated by using the equation:

$$\text{Incidence} = \frac{\text{Number of prescriptions with at least one high-risk abbreviation}}{\text{Total number of prescriptions found in each source}} \times 100$$

†Incidence rate decrease (IRD) can be calculated by

$$\text{IRD} = \frac{|\text{Post-intervention incidence} - \text{Pre-intervention incidence}|}{\text{Pre-intervention incidence}} \times 100$$

‡p=0.001 (statistically significant at α=0.05).

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the same three sources were re-evaluated using the same data collection form to assess the use of HRAs.

Data analysis

All the data collected were entered into Microsoft Excel 2010 (Microsoft Corporation, Redmond, Washington, USA) and PASW Statistics V.18 (SPSS-IBM Co, Chicago, Illinois, USA). Descriptive statistics were used to calculate the incidence of HRAs. A χ^2 test for proportions was employed to analyse the difference in the incidence of HRAs with a significance level (α) of 0.05 using a two-tailed test.

RESULTS

A total of 660 prescriptions for 482 patients from three sources (emergency wards, the pharmacy department and inpatient ICU and CCU settings) were collected before the educational interventions, and 498 prescriptions (from 388 patient records) after the interventions. Details of all prescriptions with at least one HRA and the incidence of each HRA are set out in table 2. The highest incidence of HRA was found among discharge prescriptions and dispensing records kept in the pharmacy department (72.7%), followed by prescriptions from inpatient settings (47.3%) and prescription charts from hospital emergency wards (40.9%). With respect to specific high-risk abbreviations, 14 of the 32 selected abbreviations were identified, as summarised in table 3. The five most common abbreviations recorded prior to the interventions were 'IJ for injection' (28.6%), 'SC for subcutaneous' (17.4%), drug name and dose running together (9.7%), 'OD for once daily' (5.8%) and 'D/C for discharge' (4.3%). Although these abbreviations were noted across all three prescription sources, the abbreviation 'SC' occurred most frequently in hospital emergency services (15.4%) and inpatient settings (25.9%), while 'IJ' was found principally in the pharmacy department (52.7%).

After the intervention, the relative distribution of HRAs remained similar (ie, the pharmacy department remained the highest, etc), but there was a statistically significant reduction in the incidence of HRAs across all three sources: the pharmacy department (72.7% vs 39.3%), inpatient settings (47.3% vs 23.3%) and emergency wards (40.9% vs 10.7%) (all p=0.001). The overall incidence of HRAs also decreased significantly by 52% after the interventions (53.6% vs 25.5%; p=0.001).

DISCUSSION

This is perhaps the first study of its kind in the Gulf region, particularly in Saudi Arabia, which evaluated the effectiveness of a pharmacist-led educational intervention to reduce the incidence of HRAs in acute care settings. Another study conducted in a large university hospital in Riyadh, Saudi Arabia reported a 65%

Table 3 Frequencies of high-risk abbreviations recorded in prescriptions across three sources

	Frequency of high-risk abbreviations* (%)							
	Hospital emergency wards		Pharmacy department		In-patient settings		Total	
High-risk abbreviation	Pre-int (n=220)	Post-int (n=140)	Pre-int (n=220)	Post-int (n=178)	Pre-int (n=220)	Post-int (n=180)	Pre-int (n=660)	Post-int (n=498)
1. µg	3.6	1.4	0	0	0	0	1.2	0.4
2. D/C	5.4	0	7.7	1.6	0	0	4.3	0.5
3. IJ	8.1	0	52.7	22.4	25	10	28.6	10.8
4. IU	0.9	0	5.4	0	0	0	2.1	0
5. o.d. or OD	7.7	0	7.7	1.1	2.2	0.5	5.8	0.5
6. SC	15.4	10.7	10.9	11.2	25.9	5.5	17.4	9.1
7. U or u	3.6	1.4	1.8	0	2.7	3.8	2.7	1.7
8. No leading zero before a decimal point	0.9	0	2.2	1.6	0	0	1.0	0.5
9. Drug name and dose run together -'L' ended drugs	11.3	3.5	9.0	2.8	9.0	5.5	9.7	3.9
10. Numerical dose and unit of measure run together	4.5	1.4	2.2	5.6	2.2	0	2.9	2.3
11. ASA	1.8	0	0	0	0.9	0	0.9	0
12. / (slash)	4.5	3.5	6.8	3.3	0	0	3.7	2.2
13. & (ampersand)	3.6	0	2.2	0	0	0	1.9	0
14.+ (plus sign)	1.8	0	0	0	0	0	0.6	0

*Frequency of high-risk abbreviations in prescriptions computed by

$$\text{Frequency} = \frac{\text{Number of high} - \text{risk abbreviations}}{\text{Total number of prescriptions found in each source}} \times 100$$

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decrease in use of unsafe abbreviations following the implementation of an educational intervention.[23] The ISMP recommends that reduction of HRAs is one of the most effective strategies to improve standards of medication safety.[13] This is especially because HRAs are closely linked to medical errors and life-threatening consequences but can be easily avoided when prescribing.[8] In routine practice, the pharmacist occupies a key position where errors can be identified before medication is dispensed to patients or dispatched to a ward. It is vital, however, to educate the healthcare team to adopt a safety culture that aims to avoid or minimise the use of HRAs. In this study, it was seen that the overall incidence of HRAs was 53.6%, which is higher than that reported by other studies.[20]

The educational interventions led by the pharmacist have been shown to have a positive effect on the behaviour of physicians with respect to the use of HRAs and significantly reduced the overall incidence, which is in line with the findings of other studies.[20 23 24] Taylor *et al*[20] reported a 41% decrease in the incidence rate of HRAs following a pharmacist-led intervention (31.8% vs 18.7%). Moreover, Abushaiqa *et al*[12] reported six abbreviations and dosage designations deemed unsafe, including 'U for units', 'µg for microgram', 'TIW for three times a week', 'the degree (°) for hour', trailing zeros after a decimal point and the lack of a leading zero before a decimal. Of these, three items were also identified in our study as well: 'U for units', 'µg for microgram' and the lack of a leading zero before a decimal. A possible explanation might be that these abbreviations are widely accepted; many prescribers have used them for decades and are reluctant to change.[24] Although only 14 of 32 surveyed items were actually identified as occurring in this study, this does not imply that the remaining abbreviations are unimportant, as they might nonetheless be occasionally used by healthcare professionals.

Since the highest incidence of HRAs was noted in the discharge prescriptions and dispensing records kept in the Pharmacy department, pharmacists, as the last point of contact, are the key professionals for the prevention of medication errors. Meyer suggested that ongoing educational programmes, follow-up reminders and feedback to prescribers can greatly improve prescribers' prescription-writing habits.[25] Accordingly, pharmacists should participate in an educational programme to help improve their prescription-writing skills with the use of acceptable abbreviations and feedback any medication errors on a regular basis.

CLINICAL IMPLICATIONS

There are a number of clinical implications for this study. First, the incidence of using HRAs in an acute care setting is alarmingly high, which may lead to medication errors, necessitating an action plan to discourage the use of HRAs. Second, a pharmacist-led educational intervention can potentially reduce the use of HRAs in clinical practice. Third, the use of handwritten prescriptions should be discouraged as they are sometimes illegible and prone to misinterpretation. Finally, healthcare professionals in Saudi Arabia are predominantly expatriates with a diverse educational, cultural and linguistic background, so it is important to develop safe prescribing guidelines at the local and national levels to ensure patient safety. In the USA, many organisations[24 26–28] dealing with patient safety have tried to discourage the use of error-prone abbreviations and dose expressions in healthcare settings over two decades, but the prescribing practice is only decreasing slowly. Similarly, in the UK, prescribers are encouraged to use English in place of Latin abbreviations.[29] Interestingly, 'o.d. or OD for every day' and 'o.n. or ON for every night' are considered unsafe but are nonetheless commonly used in routine clinical practice. Educational interventions on a periodic basis can be one of the ways to modify prescriber behaviour and limit the use of HRAs.

LIMITATION

The findings of this study should be considered in the context of the study design limitations. There are two main limitations. First, randomised controlled trials (RCTs) are considered as the gold standard to evaluate the effectiveness of an intervention.[19] However, quasi-experimental designs are ideal when conducting RCTs is either logistically or ethically not possible.[18] We could not conduct an RCT due to the unavailability of a suitable control group, as this emergency centre is specifically designated for pilgrims only and there was no other such facility in the region. Owing to the lack of randomisation and control groups, several threats to the internal validity of before-and-after quasi-experimental studies have been reported in the literature including maturation, the Hawthorne effect, regression to the mean, dropout and testing.[19] Second, the number of prescriptions reviewed during the post-intervention phase was about 25% less than that during the preintervention phase. As mentioned above, the study site is specifically designated for pilgrims and there are seasonal variations in the number of pilgrims. The decrease in patient numbers may have contributed to the decrease in the incidence of HRAs observed in the post-intervention phase. However, the incidence of using HRAs was reduced by 52%, which is significantly more than the decrease in the number of prescriptions seen in the post-intervention phase, suggesting a positive intervention effect.

CONCLUSION

Educational interventions led by pharmacists can be effective in reducing the use of HRAs by physicians and other healthcare providers, leading to a decrease in medication errors. In this study setting, the use of HRAs was noted to be high, which can compromise patient safety; therefore, it is essential for the regional and

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national Saudi health authorities to devise and implement policies and protocols to discourage the use of HRAs. Future research should explore the effectiveness of pharmacist-led interventions in reducing the use of HRAs in emergency and other settings using well-designed randomised controlled trials.

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Contributors AH, WWW and TMK conceived the concept. A-RRB, MEE, AAM, AZG, BFA-I, RAA and RAE assisted in the data collection and interpretation. AH, WWW, MAH and TMK analysed the results. MAH, AH, WWW and MEE compiled the initial draft. TMK, MAH and AH finalised the draft. All authors equally contributed to the study and finalisation of the manuscript.

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